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FUNCTIONAL ANATOMY OF THE DIGESTIVE BRGANS OF PAMPUS ARGENTEUS EUPHRASEN (FAM . SIRAMAEIDAE) :

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Introduction

Many contributions have appeared on the structures and funct-- ions of digestive organs of fishes . Jacobshagen (1911 , 1937) , Suyehiro (1942) , Rahimullah Qureshi (1945) and Al -- Hussaini (1947) have done valuable works on the different groups of fishes and have given exhaustive historical accounts of the researches done before . In Iraq contributions made by Al -- Hamed (1965 , 1966) on the morphology and histology of the alimentary tracts of three cyprinid fishos i . e. Barbus sharpeyi Gunther , B.grypus Heckel , and B.xanthopterus Heckel are commendable . Other than this no such work has been known from this country so far the author's knowledge is concerned .

Pampus argenteus Euphrasen (Local name : Zubeidy) is economically very important fish in Iraq and is distributed through the seas of India to Malaya Archipelako . A search in literature explores the names of Bühler (1930) , Suyehiro (1942) , Khanna (1962) , Kuthalingam (1963) , Khanna and Pant (1964) , Isokawa et al (1965) and Khanna and Mehrotra (1970) . Their

works are sufficiently exhaustive in treatment so as to give a full picture of its digestive tract . Therefore detailed studies have been undertaken to explain the anatomy of the digestive organs and to correlate their structural adaptations to the normal diet .

Materials and methods .

Fresh specimens , 100 -- 350 mm in total length (T . L .) , were obtained from Basrah -- Ashar Fish Market in June -- July , 1972 and were fixed in formalin . Dissections were made on a number of specimens for the study of gross anatomy . Alizarine Red was employed for the study of bony stuctures in the buccopharyngeal cavity . Figures were made with the help of camera lucida .

Observations

Buccopharynx .

The mouth is transverse and subterminal . The gape is equal to about 3 . 4 the length of the head . The premaxillae are paired curved bones and form the border of the upper jaw . They bear villiform teeth arranged in a single row (Fig . 1 A , B .) ; rarely a few are marked on the inner side of the row . The front teeth are slightly smaller than the back teeth which are cusped (2 -- 3 small cusps) (Fig.1,C) . They measure about 100 -- 200 micron in length and number about 40 — 45 distributed equally on each side . In Alizarine preparation their tips do not take the stain . The premaxillae meet each other in a loose symphysis anteriorly .

The maxillae are large and curved,and have expanded bony processes at the posterior ends . They overlap the dentaries of lower jaw to which they are attached by skin and ligaments .

The dentaries are paired V -- shaped bones which form the major part of the lower jaw . They curve around the anterior margin of the jaw and meet in loose symphysis . The dorsal limb of the dentary is shorter than the ventral limb and bears a single row of villiform teeth extending over its whole length (Fig . 1 D, F .) . They are occasionally shed . The front teeth are smaller than the middle and back teeth which are cusped (2 -- 5 cusps) (Fig . 1 E) . They measure about 100—220 micron in length and number about 75 — 95 distributed equally on each dentary .

The maxillary and mandibular valves are sheets of membrane situated in the oral cavity just caudad of the maxillary and mand-- ibular teeth respectively (Fig . 1 A, D.) . They are widest directly in front and taper down laterally to a point just behind the angle of the mouth . The maxillary valve is crescentic in shape and its attached edge is thick while the free edge is thin and " notched " . On its ventral surface are found small papillae scattered irregularly. Little rugae are also marked in large specimens . Melanin chromat-- ophores (stellate) are irregularly spread more in number near the attached edge than near the free edge . The mandibular valve is crescentic can "perfect" ; its middle region is covered dorsally by the free end of the tongue . The surface is smooth and melanin chromatophores are marked on its dorsal surface . An elongate ' white central thickening ' is observed in both the valves .

The roof of the buccal cavity is concave and its mucous memb-- rane is thrown into longitudinal folds.In the posterior region there

are two conspicuous rounded elevations , which are provided with small pointed teeth (Fig . 1 A) . The teeth consist of broad basal ends fixed to the ' elevations ' and tapering distal ends . At the level of second to fourth gill arches the mucous membrane forms small meshes of low thin folds. The superior pharyngeals are marked here . Their posterior ends project behind into the oesophageal sac which lie on either side (right and left) of the anterior part of the large , longitudinal dorsal ridge . In front of the sac there is a depressed triangular area , the mucous membrane of which is longitudinally folded . Tiny teeth are marked on the entire surface of the buccopharyngeal cavity , more prominently on and around the aforesaid ' elevations ' than elsewhere .

An almost rectangular tongue occupies the anterior part of the floor of the buccal cavity ; its mucous membrane forms a net of thin folds which are followed by longitudinal folds (Fig . 1 D). Low transverse folds are seen at the level of third and fourth gill arches . A small , fusiform bony structure bearing 40 — 45 teeth is noticed between the two anterior limbs of the inferior pharyngeals , which lie covered in the muscles of floor . Their length — breadth ratio is 3 . 4 : Their posterior ends 25 -- 40 tiny teeth which project into the oesophageal sac and lie on either side (right and left) of the anterior part of the large , longitudinal ventral ridge .

Oesophagus

The pharynx extends posteriorly to form a large , thickwalled, muscular sac , the oesophageal sac (Pharyngeal bulb ; Oesophageal bulb ; Prestomach) . It is soft , black and elliptical . It is marked with incomplete circular lines externally and encloses a large cavity inside , the oesophageal sac cavity which is continuous anteriorly with the pharynx and posteriorly with the stomach . In the cavity theret are two large longitudinal ridges,the dorsal and ventral ridges which meet each other to incomuletely divide the sac cavity into two small chambers (a right and a left) . (Fig . 2A) . The mucous membrane of the chambers is produced into numerous papillae or processes of different lengths . They look like extended polyps of a coelenterate and have porous tube -- like bones as revealed by Alizarine Red (Fig . 2A) : A papilla consists of two regions i . e . the basal and apical regions . The basal region is produced into 3 — 6 , rarely 8 long radial or basal processes which lie embeaad in the wall of the sac . They are thick at the attached ends and taper gradually toward the free ends . The processes of one papilla are not in contact with the processes of another papilla and occupy different levels in the muscles of the sac . The apical region of a papilla is either bluntly pointed or bifid .

A papilla is provided along its whole length with small , pointed teeth and their density toward the basal region is less than those toward the apical regions.A tooth,like a papilla, consists of two reg-- ions , the basal and apical regions (Fig . 2B) . The basal region is small , swoolen and fixed to the papilla while the apical region is

long and pointed . Their junction appears to consist of some conne-- ctive tissue fibres which run from the basal region to the apical region . They number 4 -- 150 and measure 74 -- 500 micron depending upon the length of the papillae .

Heavy accumulation of mucus is found at the base of the papillae . The ventral and dorsal folds bear transverse low folds and toward the posterior region the mucous membrane is thrown into 14 -- 18 low and high longitudinal folds which continue into the stomach (Fig . 2C) .

Stomach and intestine

The stomach is large and wide . It has two limbs which form an U -- shaped stucture (Fig : 3 A) : The first limb 'a — b' runs almost obliquely backward from behind the oesophageal sac to the posterior end of the peritoneal cavity and then turns sharply forward ventro -- sinistrally to form the second limb ' b -- c ' (Fig . 3B) . The latter is laterally compressed and remains almost covered by the pyloric caecae , liver and ovarp : It coursesi upuard and backward to pass into the intestine (duodenum) ' c — d ' lying between ' a -- b and ' b -- c ' .

Longitudinal folds of the stomach , 10 — 12 in number , are the posterior continuations of the oesophageal folds and their junction is marked at a prominent transverse or circular thickening (Fig . 2C) . The low folds of the sac merge into this thickening while the high folds continue into the stomach and become broader than thoes of the sac . The folds fade toward the posterioe end .

The intestine is a long convoluted tube which follows back —

and — forth winding in the small compressed peritoneal cavity (Fig . 3 B) . It is divisible into duodenum , ileum and rectum . The intestine , after forming 6 — 7 coilings with extra bends at the anterior and posterior regions of the cavity , opens at the anus . The relative length of the gut (R.L.G.) is 2 87 — 4.25 The mucosa are raised into serpentine longitudinal folds , about 25 — 30 in the third and fourth limbs . In the rectal region straight longitudinal folds , 10 — 12 in number , appear which end in the anus . Ileo -- rectal region is marked internally by a circular lip of the ileo — rectal valve (Fig . 2 D) .

Pyloric caecae (Appendices pyloricae ; intestinal caecae) are the finger — like outgrowths arising from the duodenum . They are in dendrite form with complicated branched tufts . There are 3 — 6 main caecal stems ; each gives 3 — 6 branches which divide and subdivide into four small caecal diverticulae (Fig. 3 C , D .) . They number about 500 — 760 and are spread over the stomach and the intestine . Intestinal folds pass into the caecae which appear filled up with semidigested food substances .

Liver

The liver is reddish brown and consists of the two main lobes , one on either side (left and right) of the stomach . The left lobe is larger than the right lobe and they measure about 40x23 mm and 26 x 15 mm respectively in a 200 mm (T. L.) specimen (Fig . 3 E, F.) . The lobes are roughly triangular in form with the broad ends placed anteriorly and are connected above to a median strip of liver . It extends backward from behind the oesophageal sac to the

posterior end passing downward between the two lobes of the ovary. Gall bladder is roughly elongate situated behind the sac . Bile duct opens into the duodenum . Pancreas is scattered collectively below the lobes of the liver and pyoric caecae .

Digestive tube was found to be empty or to contain some quantities of gelatinous substances . In some specimens small black pellets , 2 — 10 x 0 . 6 — 0 . 8 mm containing isopod and copepod larvae , were taken from the fourth and fifth limbs of the intestine .

Discussion

Kyle (1926) stated " ...... attempts to correlate the difference in structure of the digestive system to the nature of food have so far been quite unconbincing " . Suyehiro (1942) obtained some interesting and positive results on the relationship between the form and construction of the digestive tract and their feeding habits in fishes . In the case of Pampus argenteus Euphrasen such relation--ship exists as explained in the following lines .

In the oesophageal sac there are well organised teeth which compensate the buccopharyngeal cavity . The posterior ends of the pharyngeals (two from the inferior pharyngeals and two from the superior pharyngeals) project into the sac cavity and probably help in mixing the food substances for trituration by teeth .

The radial processes of the different papillae are not in contact with each other and occupy different levels in the muscles of the sac . Such an arrangement of the processes and papillae appear well adapted for the storage of food in the sac .

The winding Remae of intestine in P: argenteus is complicated: Suyehiro (1942) noticed that Stromateoides argenteus has two kinds of intestine . one that is very long and another that is broader and trifly shorter . In the present observation the author has met the long and complicated type of intestine but not the " broader and trifly shorter type ofintestine " in P . argenteus ,

It is generally accepted that the value of R. L. G. depends upon the type of winding in fishes . Carnivores have less R. L. G. and herbivores have greater R. L. G. Suyehiro (1942) pointed out that generally herbivorous fishes have long intestines , which is not always true : Mookerjee and Das (1945) stated that the fishes are neither strictly herbivorous nor carnivorous and rather they are omnivorous . Al -- Hussaini and Kholy (1954) mentioned that the R. L: G: depends upon the amount of the plant matter in the diet , the more it is , the great the length of the stomach . R.L.G. in P. argenteus is 2:87 -- 4.25 87--4:25:No stomach content except some gelatinous substances and crustacean larvae was dete-- cted . It can be said that that P. argenteus is an omnivore inspite of its high value of R. L. G. and thus the author agrees with Mookerjee and Das (1954) and Suyehiro (1942) .

Summary .

The gross morphology of the digestive organs of Pampus argenteus (i . e . Zubeidy) has been studied .

The upper and lower jaws bear villiform teeth , the front are bluntly pointed and the middle and back teeth are cusped . Buccopharyneal cavity is provided with tiny teeth . Two rounded

elevations with small teeth are found on the roof . Cresecentic type of maxillary and mandibular valves are present . The cavity of the oesophageal sac is incompletely divided into two chambers . Papillae are of different lengths and are provided with tiny teeth . The radial processes of papillae remain separate from one another . A circular ileo — rectal valve separates the ileum from rectum internally . The intestine is coiled (6 — 7 Ioops) with extra bends . R. L. G. is 2 . 87 — 4 . 25 , The oesophageal folds are longitudinal and continue into the stomach . Intestinal folds are serpentine longitudinal and become straight at the anal end . Pyloric caecae are in dendrite form with 3 — 6 main stems which become secondarily branched . They number 500 — 760 .

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Explanation of Figures

Fig . 1 .

A — Roof of buccal cavity , C — Back teeth of upper jaw enlarged , D — Floor of buccal cavity , E — Back teeth of lower jaw enlarged , F — Right lower jaw .

an — angular , bs . bony structure , dl — dorsal limb , dn — dentary ; ds — dental area of superior pharyngeal , em — enamel, es — oesophageal sac , gl — gill lamella , lf — longitudinal fold , Ip — inferior pharyngeal , md — mandibular valve , mf — net of folds , mg — median groobe , mt — maxillary teeth , mth . mand--ibular teeth , mv — maxillary valve , mx — maxilla , pp — papilla, pr — posterior process of superior pharyngeal , px — premaxilla , rg — rugae , sp — superior pharyngeal , ta — triangular area , tf — transverse fold , tg — tongue , th — tooth , vl — ventral limb , xp — cusps .

Fig . 2 .

A — Transverse section of oesophageal sac , B — tooth of papilla , C — Oesophageo -- stomach folds , D — Ileo -- rectal valve .

ap — apical region of tooth , bc — basal region of tooth , dlr — dorsal longitudinal ridge , ef — oesophageal ridge , ef — oesophageal fold , em — enamel , irv — ileo — rectal valve , jf — junction of oesphageal and stomach folds,lf — longitudinal fold , ms — muscles , pa — apical region of papilla , sf — serpe--

ntine longitudinal folds , st . stomach , tf — transverse folds , rp — radial processes , vlr — ventral longitudinal ridge ,

Fig . 3 .

A — Digestive tract , B — Winding of digestive tract , C — Pyloric caecae (left lateral view) , D — Pyloric stems (right lateral view) , E — Left lobe of liver , F — Right lobe of liver .

dd — duodenum , es — oesophageal sac , pc — pyloric caecae, ps — pyloric stems , st — stomach .

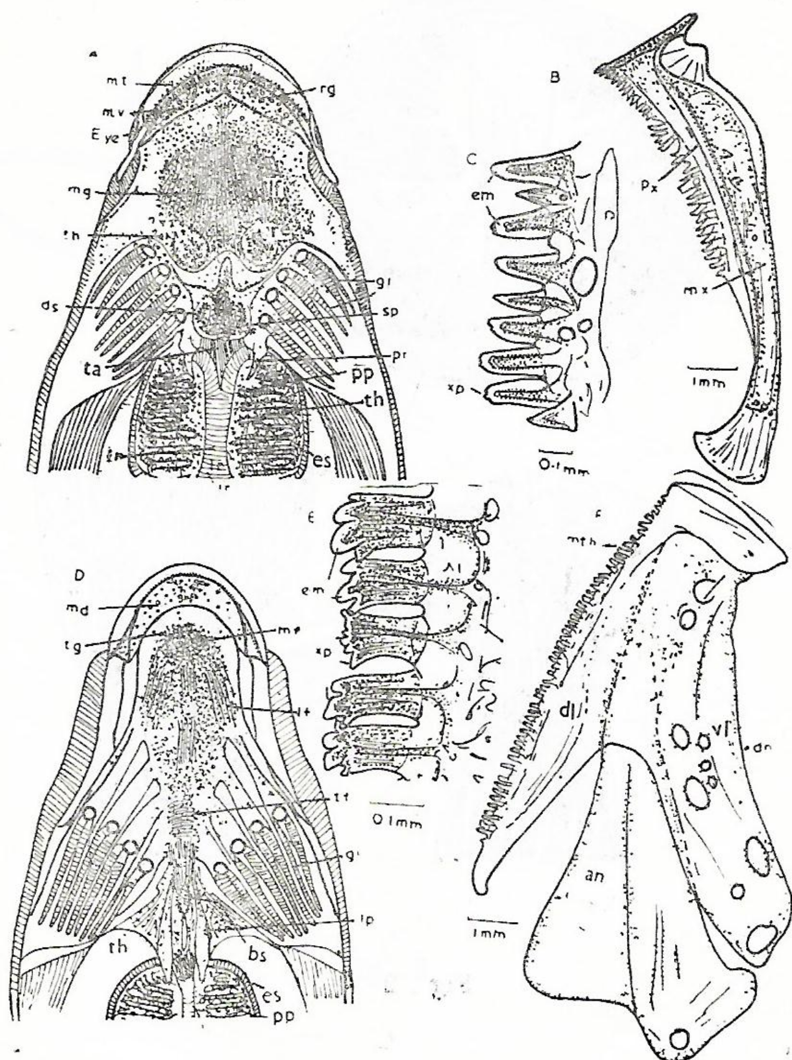

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Fig . 1

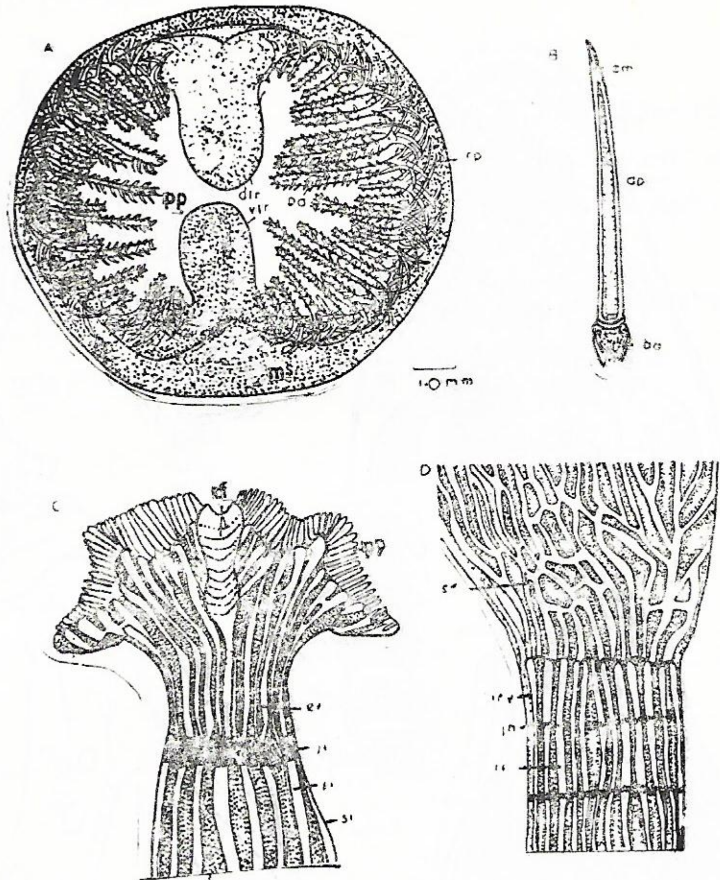


Fig . 2

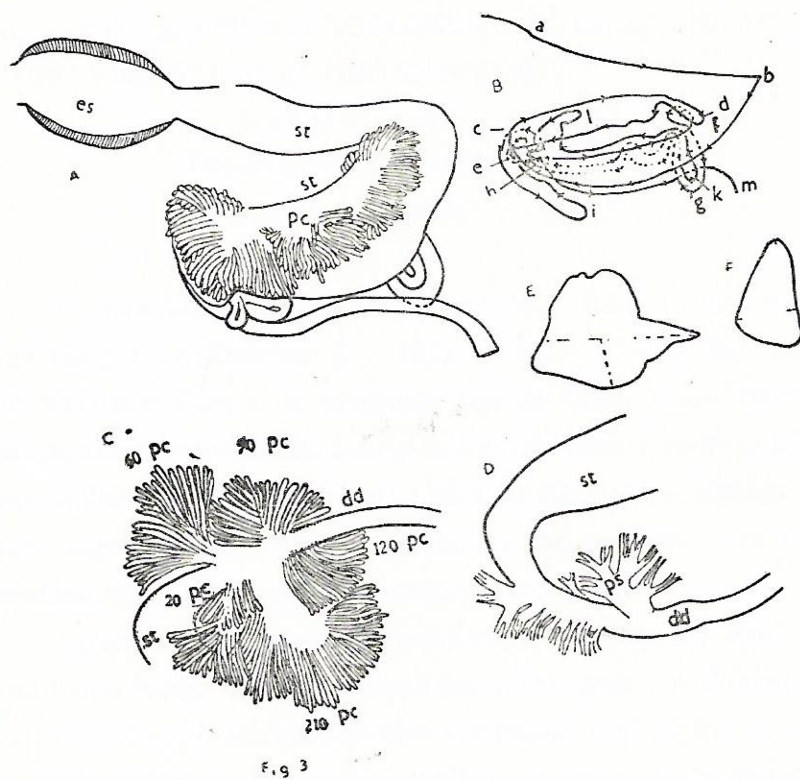

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